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THE TEXAS LEAF-CUTTING ANT (ATTA TEXANA BUCKLEY) AND ITS CONTROL
IN THE KISATCHIE NATIONAL FOREST OF LOUISIANA

by

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The Occasional Papers of the Southern Forest Experiment Station present information on current Southern forestry problems under investigation at the Station. In some cases these contributions were first presented as addresses to a limited group of people, and as "occasional papers" they can reach a much wider audience. In other cases, they are summaries of investigations prepared especially to give a report of the progress made in a particular field of research. In any case, the statements herein contained should be considered subject to correction or modification as further data are obtained.

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Introduction

Although for a long time the Texas leaf-cutting ant has been known to defoliate plants in Texas and Louisiana (3 and 4) 2/, it was not until late in 1934 that these ants were recognized by officials of the Federal Forest Service to be serious pests of young pine trees.

At the request of the Forest Service, T. E. Snyder early in 1935 made recommendations for the control of this ant on the Kisatchie National Forest in Louisiana. The results of this preliminary control work, together with data on the biology and distribution of the ant, were published in January 1937 (6). Here it was shown conclusively that the ant is a serious pest of young pines and that control operations are practicable and definitely warranted.

During the fall of 1936 and the spring of 1937, approximately 100 ant colonies on the Kisatchie Division of the Kisatchie National Forest were treated by the Forest Service with carbon bisulphide (CS_2) in a routine manner as part of a control project. Great credit should be given to P. J. Ceremello (1) for devising better technique, namely, use of a funnel and hose, during previous control operations, and to C. R. Crawford (2) for putting these control operations into effect. Special data were kept on the time of treatment, amount of chemical used, and costs. In addition, 78 colonies were treated on other Divisions of the Forest at this time, but owing to lack of time it was not possible for the writer to check or investigate the work done on these Divisions.

In the summer of 1937 (June 1 - Sept. 1), the writer carried on extensive poisoning experiments with the aim of determining whether or not the ant could be controlled by summer treatment during the period of slack work, and also to ascertain if any other chemicals were more efficient than CS_2 in the treatment of the nests; under efficiency was included their relative toxicity, cost, practicability in handling, etc.

This paper deals mainly with the results of the poisoning experiments conducted in the summer of 1937, but the writer also was able to check on the work done in the winter of 1936 and the spring of 1937 by the Forest Service. In addition valuable data were gathered during this work relative to distribution, relation to soil and vegetative types, habits of the ant, etc.

1/ This article was prepared while the author was temporarily employed by the Federal Forest Service, under a cooperative agreement between the Southern Forest Expt. Sta. at New Orleans, La., and the Bureau of Entomology and Plant Quarantine. Under the supervision of Thomas E. Snyder of this Bureau, the author was assisted in the field work by Paul Schuler and J. R. Sonderegger, student assistants employed by the Forest Service.

2/ Italic numbers in parentheses refer to literature cited at end of this paper.

Damage

The attacks of this ant on young planted pine trees occur in the late fall, winter, and early spring when there is a dearth of other green foliage. The injury consists in the cutting off of the needles close to the bud of the seedling in longleaf pine and the cutting off of both the needles and bud, as well as girdling of the living bark, in slash pine.

The injured longleaf pines are weakened, but the damage resulting from defoliation appears not to be so severe, unless drought or other factors also affect the tree, when it may succumb, resulting in a much higher mortality than indicated at the first part of the season. In the case of slash pine, the injury results in the death of the trees. After trees have become 2 to 3 feet high, they seem to have grown beyond the stage of fatal injury. Unfortunately this damage coincides with the planting season, December to March.

Another type of injury is to longleaf pine seedlings in the cotyledon stage under conditions of natural reproduction, and here 100 percent loss has occurred in areas immediately adjacent to the ant colonies.

No accurate data on the percentage of pine trees killed by ants or the monetary loss involved are at hand; at this time so many factors are involved that not even estimates can be given. Such data would have to be accumulated on a large scale and over a number of years to obtain a fair index of the loss occasioned by ants, which are capable, however, of attacking any young pines within a radius of 300 to 400 feet of their nest.

The Ant

The ant is known to entomologists as Atta texana Buckley or the "Texas leaf-cutting ant." There are many other common names applied to this species, however, such as "night ant," "parasol ant," "pack ant," "cut ant," and "fungus ant." In Louisiana the ant is spoken of by farmers as the "red town ant" or "chisel head," the former designation being most common. It is the only ant that has a pronounced defoliating habit (in its restricted area of distribution), and in Louisiana it can be recognized by its characteristic nests, which consist usually of large, irregular, bare surfaces of soil with numerous and irregular reddish craters scattered over them. Owing to the reddish subsoil brought to the surface by the ants, the general surface of the nest usually has this characteristic color.

Distribution

The Texas leaf-cutting ant, so far as is known, is confined entirely to Louisiana and Texas, although its exact range has not yet been mapped very accurately. According to reports sent by R. R. Reppert (5), Extension Entomologist of Texas, the ant might be said to occupy approximately all of Texas (from the extreme southern boundary almost to the Oklahoma line) east of the 102° meridian and thence eastward into western Louisiana as far as the 92.5° meridian. In Louisiana, the ants are definitely known to occur in 13 parishes: Bienville, Webster, Sabine, Vernon, Beauregard, Allen, Calcasieu, Jefferson Davis, Rapides, Natchitoches, Grant, LaSalle, and Winn (see map). The record cited previously for Washington Parish is an error. This ant is not a recent introduction into Louisiana, but owing to the fact that it is found largely on nonfarming areas or waste lands, it has previously escaped much attention.

It should not be concluded from an examination of the map that the ant is continuously or uniformly present throughout its range, because it is limited by at least three distinct factors, which account for its sporadic distribution, namely, soil type, topography (including drainage), and exposure.

Within the range of distribution of Atta texana in Louisiana (see map) there are 14 types of soil, according to the Atlas of American Agriculture for 1935, published by the U. S. Department of Agriculture. A number of these, however, are unsuited for it because of their physical character and poor drainage. The ants are especially common in the lighter phases of the Susquehanna, Norfolk, Orangeburg, Cuthbert, and Ruston fine sandy loams and may occur in soils of a similar nature that contain not less than approximately 60 percent sand in the surface soil. The subsoils of these lighter phases are generally of such a nature that they cannot be compressed into definite balls by the hands as can the heavier soils. Colonies in Louisiana are always located on well-drained sites, that is, crests of ridges, promontories, or the sides of hills; they are never in low areas or in heavy or poorly drained soils. Although there are favorable soils in Louisiana outside the known area of distribution, for some reason not yet determined the ants do not occur there.

It will be seen from this that the ants show a distinct preference for sandy or sandy loam soils, but Walter (7), who made an extensive study of the ant in Texas, states that although the ants there show in most cases a preference for such soils, he has known them to live in heavy soils or in those of limestone origin. In Louisiana their distribution is almost coextensive with that of longleaf pine. In a general way it might be said that the ants live in a longleaf pine habitat in which there is a loose sandy type of soil and in which scrub oaks are also common.

There seems to be a close correlation between the location of ant colonies and exposure. A check of 38 nests showed 17 on southern slopes, 13 on western, 5 on eastern, and 3 on northern. Location of the nests on southern and western slopes would give the ants the advantages of retaining much of the accumulated daytime heat throughout the night. J. A. Hyslop, in a letter to the writer, calls attention to the fact that the ant's northern distribution may be determined by temperature: "The northern lines of known distribution of the insect coincide very nicely with the southern limit of 10° F. annual minimum temperature."

Number of Colonies per Acre

It is difficult to give very exact data on the number of ant colonies per acre. On the planted areas in the Kisatchie National Forest, there is a great amount of variation depending on soil types, exposure, drainage, vegetation types, etc. A general average based on a large number of typical planting areas in the Kisatchie National Forest shows an average of about one ant colony per 90 acres. In an area extremely ill adapted to the nesting of these ants, Crawford found only 4 colonies in 2,800 acres. From conversations with farmers living in rather favorable nesting areas for the ants, it was learned that one colony may be expected on approximately every 15 or 20 acres. Under extremely favorable conditions, however, several colonies may be separated by only a few hundred yards.

Nesting-Site Indices

One of the most important phases of control work is the locating of colonies for treatment, since it is clearly evident that untreated colonies, or parts of colonies, will be a constant source of future loss.

In scouting for the ants one should keep the following points in mind: (1) they prefer only sandy or sandy loam soils; (2) their nests are **always** located on well-drained sites such as promontories or the **sides** of hills and (3) the nests are more common on **western and southern exposures**.

The general nest area (center of the colony) may cover from less than 100 square feet to as much as 3,000 to 5,000 square feet, depending upon the age of the colonies. The general nest area usually consists of a bare surface, which is raised several feet above the rest of the surrounding soil. As it is washed down by rains, it is constantly built up with subsoil brought up from below. In a large part of the Louisiana range of the ant, the subsoil is reddish, giving a very characteristic color to the nest area. Scattered over the general nest area will be found innumerable variously shaped mounds—crater shaped, crescent shaped, etc.—but sometimes the holes are left flush with the surface of the earth, and no soil is piled around to form distinct mounds.

If a nest is large, and consequently old, grass may be growing over parts of it, or it may have caved-in holes, some 4 square feet in area or larger; these are due to the great excavation work beneath, assisted by weathering. Around many of the older nest areas, there are dense clusters of dog fennel, Eupatorium capillifolium Small, which in some regions serves as an excellent nest-site index. Two explanations for this ring of dog fennel around the nest are: The seeds of the plant may have found the loosely pulverized soil dumped there by the ants an especially good site; or the ants in bringing seeds to their nest, as they often do, may have accidentally dropped them there. The former reason seems more plausible. Many nests are surrounded by small, rather dense growths of scrub oaks.

As one leaves the main nest area, he will observe small mounds scattered rather irregularly here and there, often far apart. The farther one gets from the nest, the less numerous are these mounds, most of which represent the lateral galleries that extend from the nest and are used as entrances and exits for the ants in their foraging expeditions. These foraging holes often can be found 300 feet or more from the nest; one measured was 317 feet from the main colony and was 18 inches to 6 feet beneath the soil. Furthermore, ants in foraging may go several hundred feet beyond the last foraging hole; ants were observed cutting leaves from a tree 480 feet distant from the colony. Most of the laterals are down slope, since the ants occupy the crests of ridges

In summer, especially during the hot part of the day, the ants remain in their nest below the surface of the soil; hence their activity cannot be relied upon to locate the nest or to determine the size and condition of the colony. Scouting is also more difficult in summer because of the density of plant growth, which conceals the ant nests; but in winter, when the ground is rather bare and the trees and shrubs are denuded of their foliage, one can often detect an ant colony on a hillside as far away as one-fourth of a mile.

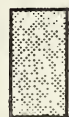
MAP SHOWING DISTRIBUTION OF ATTA TEXANA
IN LOUISIANA ON VARIOUS SOIL TYPES

LEGEND



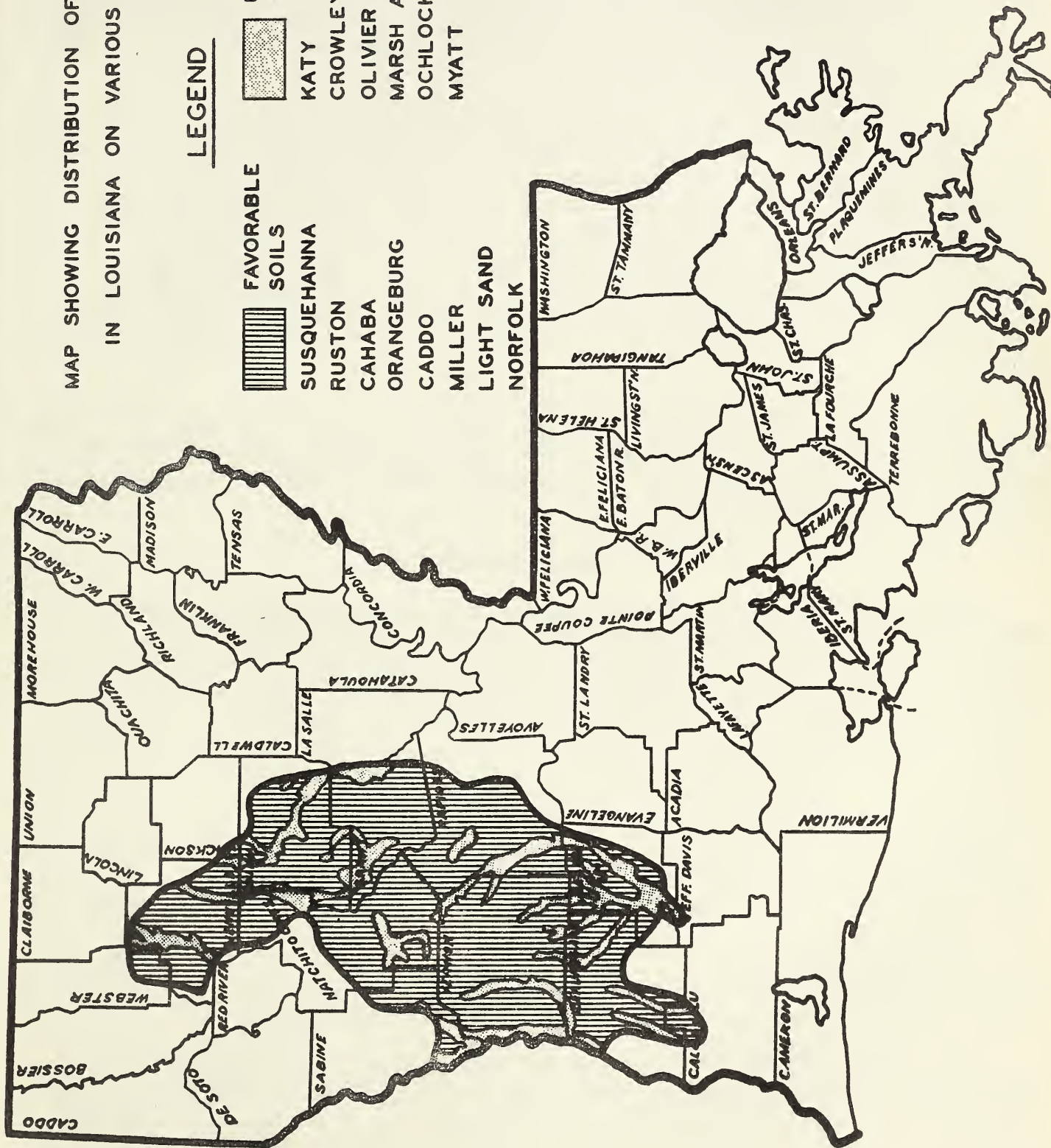
FAVORABLE
SOILS

SUSQUEHANNA
RUSTON
CAHABA
ORANGEBURG
CADDO
MILLER
LIGHT SAND
NORFOLK



UNFAVORABLE
SOILS

KATY
CROWLEY
OLIVIER
MARSH AND SWAMP
OCHLOCKNEE
MYATT



The Nests

The larger nests in Louisiana occupy a considerable surface area and have innumerable craterlike mounds clustered irregularly over the surface. The depth to which nests extend in the soil is amazing, namely, 10 to 20 feet. So far as is known, no other North American ant approaches this species in the depth to which it constructs its nest.

An excavated nest is found to consist of hemispherical chambers with flat floors and arched roofs. In these chambers, which are connected by galleries, the ants live, their only food being a fungus that they grow upon macerated leaves cut from vegetation.

The interconnecting galleries range in size from the width of a finger to 2 inches or more. The chambers, which are usually first encountered 2 to 3 feet below the soil surface, may extend to a depth of 15 feet. Two types of galleries lead into the main nest: those that lead almost vertically down from the nest surface above; and others, which might be termed laterals or feed holes, that have a horizontal trend and may lead 300 feet or more from the nest. The vertical galleries, which are more angular or spiral in their construction, are apparently used principally for removing excavated earth and perhaps also for ventilating. The horizontal galleries are used mainly for bringing in excised leaves.

The number of holes per ant nest, including those from both lateral and vertical galleries, is astounding. Some colonies studied had approximately a thousand, and a few exceptional ones had less than a hundred; the general average was several hundred.

Colony Activity

The activities of a colony depend largely on suitable temperatures for work. During the hotter months of the summer the ants remain quiescent during the day, but with the coming of dusk and lower temperatures they begin to forage and to excavate their nests, continuing during the night. Evidences of their night activity are the freshly excavated mounds and the bare, smooth trails leading from their forage holes to some plant that they have been defoliating. These trails may be from 1 inch to 3 or 4 inches wide, and if they did not contain particles of excised leaves, accidentally dropped by the ants, one might think they were made by a snake. In summer most of the nest holes are plugged with earth or ligneous debris. Although most of the ants are quiescent during the day, occasionally a few workers are excavating, or even foraging, but they do not wander far from the nest because of the heat of the sun.

In winter the ants forage during the day instead of at night. At temperatures between 45° and about 80° to 90° F., they are active, but they are not active on cold, wet, or cloudy days, especially in the morning.

The effect of extreme heat on the ants was well brought out by an "experiment" conducted near Provencal, La., in August 1937. Workers of different sizes were taken from an active colony and dropped on the hot sand, the temperature of which ranged from 123° to 130° F. Various workers died within 6 seconds to 1½ minutes at these temperatures, the larger ones being more resistant to the extreme heat than the smaller. After an individual had lost control of its legs and tumbled over on its back, death proceeded rapidly, and the last struggles were indicated by twitching of the antennae and legs

Control Investigations

During the summer of 1937 various chemicals were tested as soil fumigants in an attempt to determine whether summer treatment was as effective as winter treatment, and also to ascertain whether any of these chemicals were more effective and cheaper than carbon bisulphide (CS_2). The chemicals used were CS_2 , trichlorethylene, gasoline, hydrocyanic acid gas, and hydrogen sulphide. In all, 66 nests of different sizes were treated with these chemicals in varying proportions, and apparent eradication was obtained in only 3 of the 66 nests, namely, those treated with CS_2 .

Thirty-eight experiments were conducted with CS_2 , using it at rates varying from $3/4$ pint to 25 pints per colony. Every ant hole was staked out and the chemical was then injected into some of the holes by means of a small funnel with rubber tubing attached. On the main nest, holes about every 10 feet were treated with the liquid at rates varying from $1/4$ pint to a pint, and holes outside the nest at from $1/8$ to $1/4$ pint. All holes were plugged whether treated or not. In only 3 of the 38 colonies treated with CS_2 were the ants eradicated, In many the ants were reduced in numbers appreciably, but the amount of poison required, the cost, and the general results obtained showed very clearly that poisoning was not practical or effective in the summer.

Another chemical considered to be a possible substitute for CS_2 was trichlorethylene, a liquid which volatilizes on exposure to air, is heavier than air, is cheaper than CS_2 , and is not inflammable or explosive at ordinary temperatures. So far as is known, this chemical has not been used previously as a soil fumigant for ants. Seven tests were conducted, using the liquid in the same manner as CS_2 and at rates varying from 2- $1/8$ pints to 17- $5/8$ pints per nest. No eradication was obtained in any of the tests, and reduction in numbers was very slight in most of the colonies treated.

Since gasoline was not expected to be an effective control for ants, only two tests were conducted. In one test 9 pints were used, and in another 12 pints. Eight holes on the main nest of each colony were treated with a pint of gasoline per hole, and the remainder injected into outside holes at rates of $1/7$ to $2/5$ pint per hole. Both the treated colonies were unusually small and should have been eradicated if the gasoline was at all effective, but both colonies showed scarcely any effect of the treatment.

Hydrocyanic acid gas, derived from potassium cyanide (KCN) crystal "eggs" by dissolving 1 ounce of the cyanide in a half gallon to a gallon of water, was used in 13 colonies. The solution was poured into holes on the main nest and into outside holes by means of the funnel and rubber tubing, the same as the CS_2 . The heaviest dosages were injected into the holes of the main nest, while varying dosages were placed in the outside holes; 2 to 24 ounces of KCN crystals were used per colony. Not a single colony was eradicated, and the reduction of the ants in all cases was negligible. Furthermore, this chemical has many objectionable features: It forms a gas lighter than air and thus does not penetrate into the lower chambers; it requires a supply of water in the field at all times to form the gas; and it is an extremely dangerous poison to use in both solid and gaseous states.

Hydrogen sulphide gas (H_2S), although very toxic to animal life and not inflammable or explosive at temperatures above the average, is lighter than air and has a most disagreeable odor. The gas was injected into holes on the main colony with a rubber tubing which led from a tank in which it was under high compression. Since 2 to 10 ounces (and more) of the gas was used per colony without any appreciable reduction in numbers, this chemical offers no promise whatever as a cheap and effective means of controlling the ant.

CS_2 was the only chemical that showed any appreciable effectiveness, and even it did not reduce the number of the ants enough to warrant the large amount of material required or the expense entailed. Summer treatment for the ants, therefore, is not recommended under any conditions or with any chemical.

One of the main phases of investigation carried on during the summer was to check as many colonies as possible in the Kisatchie Division of the Kisatchie National Forest to determine whether the poisoning carried on there during Jan.-Mar. 1937 by C. R. Crawford had been effective in either eradicating or controlling the ants. Although approximately 100 colonies had been treated, using an average of 6.75 pints of CS_2 per colony, time permitted the writer to check but 38, which were selected at random in order to give as fair results as possible. The results of this inspection are given in table 1. Of the 38 colonies treated, 26 showed complete eradication,^{3/} 10 showed at least 99 percent eradication, and 1 showed nearly 95 percent; only one showed little effect of the treatment, indicating that for some unknown reason the gas did not reach the colony.

Two colonies were treated during the last of January, 26 in February, and 10 in March. Fifty percent of the colonies treated in January were eradicated, whereas 70 percent of those treated in February and March were eradicated. Walter (7), in working with the ants near San Antonio, Tex., states that he obtained the best kill with CS_2 from late February to early April; he believes the reasons for this are that the ground is then warm enough for rapid evaporation of the chemical, and the ants are more concentrated in the nest than later. He also states that in 99 nests treated between Feb. 5 and April 16, the ants were killed in 88 with the first treatment, whereas 10 required a second treatment and 1 required a third.

The colonies treated by Crawford ranged in size from $\frac{1}{4}$ acre to $1\frac{1}{2}$ acres, and the number of holes treated was 25 to 300. The cost of treating was 2 cents per hole, or approximately \$2.08 per acre, including materials, labor, and transportation.

In the Kisatchie National Forest during the winter of 1936-37, 178 colonies were located and treated in fenced areas that aggregated 18,790 acres. The colonies averaged 300 holes each, 74 of which (average) were treated. To treat adequately an average colony required 7.2 pints of the chemical. The cost per hole thus averaged 3.4 cents; and the cost per acre, \$3.06. The cost prorated against the entire acreage, protected as well as treated, would be 2.3 cents per acre. The average planting cost for the 1936-1937 season was \$5.53 an acre.

^{3/} No ants active in any forage hole. The percentages of incomplete eradication are estimates based on the number of forage holes in which ants were active.

Table 1. - Colonies of Atta texana treated with CS₂ by C. R. Crawford
Jan.-Mar. 1937, and checked by M. R. Smith in Aug. 1937 to
determine the efficiency of the control measure

Colony	When treated	Size	Holes treated	Amount of CS ₂ used	Time required		Efficiency of control
					CCC	Supervision	
<u>Number</u>	<u>Date</u>	<u>Acres</u>	<u>Number</u>	<u>Pints</u>	<u>- - Man hours - -</u>		<u>Percent</u>
1	Jan. 27	1	125	10	3	1	94.6
2	30	3	300	24	4	4	100
3	Feb. 1	$\frac{1}{2}$	300	16	6	4	99.3
4	1	2	100	4	3	2	100
5	2	2	100	6	2	1	100
6	2	$1\frac{1}{2}$	120	6	3	-	100
7	2	$\frac{3}{4}$	120	16	4	-	99.3
8	4	$\frac{1}{2}$	-	-	4	-	100
10	4	1	100	6	2	1	100
11	5	$\frac{3}{4}$	75	4	1	1	100
12	5	$\frac{1}{4}$	50	4	1	1	100
13	8	$\frac{1}{4}$	70	4	2	-	100
14	8	$\frac{1}{4}$	100	8	3	-	99
15	8	$1\frac{1}{4}$	200	16	6	-	100
16	9	$\frac{1}{2}$	25	4	1	1	99.3
17	9	$\frac{1}{2}$	50	4	3	1	100
18*	10	1	100	8	3	2	almost 0
21	10	$\frac{1}{2}$	100	8	1	1	100
22	10	1	100	8	3	2	100
26	11	$\frac{1}{2}$	50	6	1	1	100
27	11	$\frac{1}{2}$	50	4	$1\frac{1}{2}$	-	99
28	24	$1\frac{1}{2}$	150	8	$4\frac{1}{2}$	$1\frac{1}{2}$	99.3
29	24	$1\frac{1}{4}$	125	6	3	$1\frac{1}{2}$	100
32	24	$1\frac{1}{2}$	125	4	3	1	100
34	25	1	100	6	3	1	100
35	25	1	100	6	3	-	100
37	25	$\frac{1}{2}$	65	4	2	1	99.3
40	26	2	150	8	6	1	100
43	Mar. 2	$\frac{1}{4}$	50	4	2	1	100
47	5	1	50	4	2	-	100
50	5	1	100	3	3	1	99.3
51	24	$\frac{1}{2}$	75	$1\frac{1}{2}$	$1\frac{1}{2}$	1	100
54	24	1	100	3	3	1	99.3
55	24	1	130	4	2	1	100
56	25	$1\frac{1}{4}$	150	6	3	1	99.3
57	25	2	200	10	4	1	100
70	29	$\frac{1}{2}$	50	2	2	1	100
75	30	1	120	4	3	1	100

*The difference between these results and those found in the rest of the experiment indicate that the gas probably did not reach the colony.

Conclusions and Recommendations

It has been shown conclusively not only that the Texas leaf-cutting ant can be controlled with CS_2 , if the colonies are treated thoroughly and at the proper time of year, but also that colonies can be eradicated, although in a small number of cases this may require more than one treatment. The ants can not become reestablished before the young trees reach a height beyond the stage of fatal injury. Since the planting season begins about Dec. 1 in the Kisatchie National Forest, it will be necessary to treat the colonies several weeks in advance; if it has been decided a year before planting what areas are to be planted the following year, the colonies can be treated during February and March of that year. The following method of treating ant colonies, devised by P. J. Ceremello, is recommended:

"Planting areas will first be reconnoitered, and ant town locations noted on a map. This survey will allow an estimate to be made of the amount of carbon bisulphide needed and will also assist control during the treatment period. If, however, the planting crews locate towns that have not been treated, they should flag them and report them for treatment.

All known ant colonies will be treated prior to planting.

Field equipment for each man will consist of a 1-gallon can of bisulphide and a 5-foot section of $\frac{1}{4}$ -inch enema tubing with a small funnel attached.

The crew of two or more men (depending upon the size of the area to be treated) will gridiron the ant town by progressing along lines 10 feet apart, using flags, if necessary, and will treat one or two holes within each 10-foot square (100 square feet of area) as the crew progresses along the line. Especial attention should be given to the south, west, and east slopes.

Since success of this treatment depends upon keeping bisulphide in and the fresh air out of the passages, it is very necessary to insert the tube deep down into the passage (best done by a twisting push) before the bisulphide is poured in, and be certain that all openings (not only the treated, but the untreated as well) are stamped closed.

A lever-type clothes pin will be used on the tube just below the funnel to prevent the carbon bisulphide from passing through the tube until the funnel is filled. The same effect can be obtained by pinching or kinking the tube with the fingers.

One funnel full of carbon bisulphide (approximately 1/10 pint, or 2 ounces) will be applied to each passage treated.

Indications are that ants are most active during mild weather and least active on hot, cold, cloudy or rainy days. Treatment will be most effective on days of least activity for then the ants will be gathered in their chambers and chances of extermination will be good. However, do not wait for ideal days to treat known ant populations.

"Precautions

Carbon bisulphide is both poisonous and highly explosive and foremen should caution enrollees in its proper use. Smoking while using or in the vicinity of carbon bisulphide is prohibited because of its explosive qualities. Carbon bisulphide will be transported in suitable drums and on grounded trucks. Safety regulations as outlined in related correspondence will be observed in transporting and using this material. Foremen should explain reasons for caution to enrollees.

"Maps and records

A map of the area should show the location of each ant colony, using the symbols AC-1, AC-2, etc. The location of ant colonies will be marked on the ground with a temporary stake, or by a blazed nearby stump or scrub oak. One of these will be scribed with keel to show the ant colony number. A record (see enclosure) will be kept at camp and show progress of costs and treatment. The items listed are: Date of treatment, and for that day the ant colony number, acres treated, pints of bisulphide used, man hours for CCC and supervision and truck miles."

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